Fig. 1

BACKGROUND ART

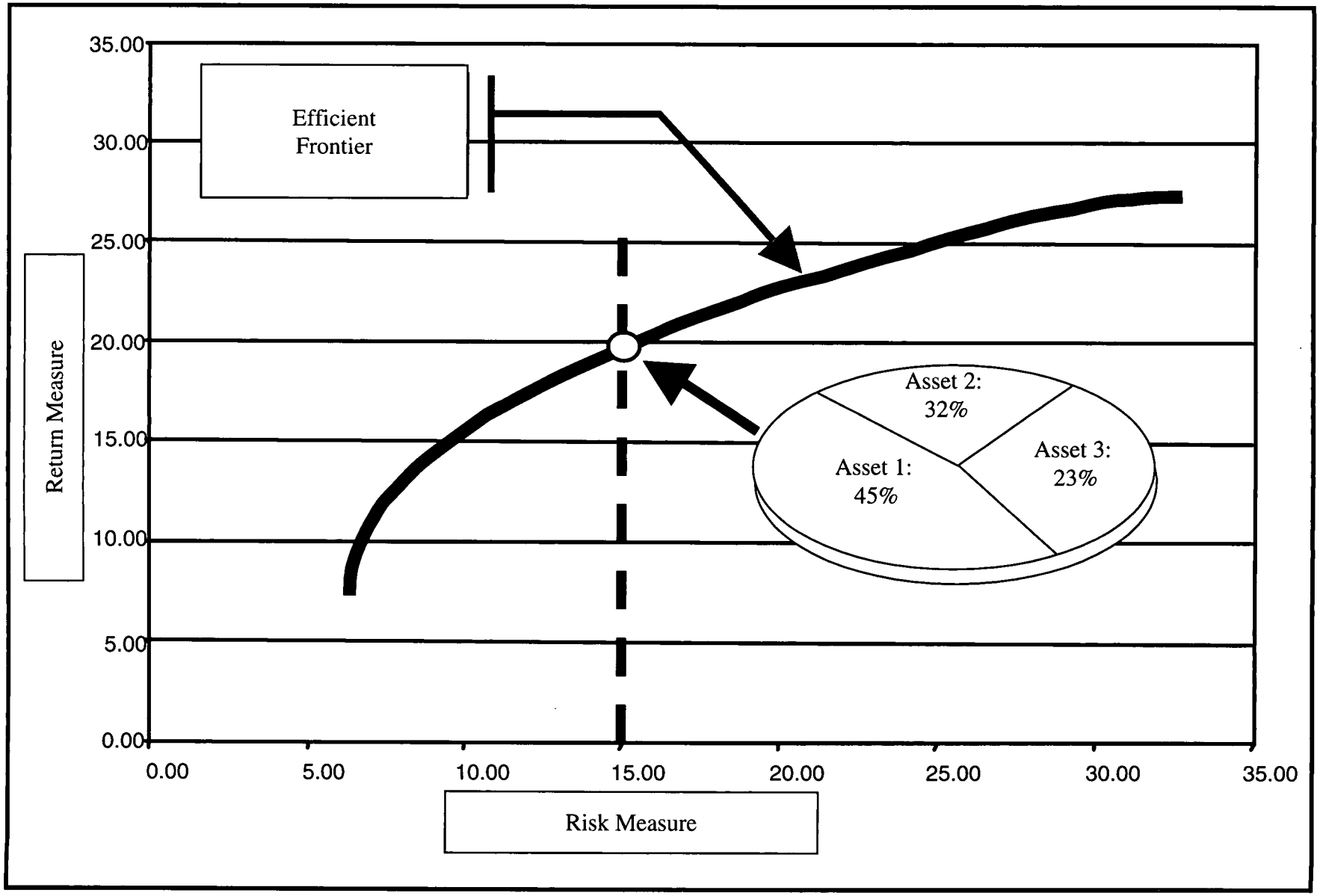


Fig. 4

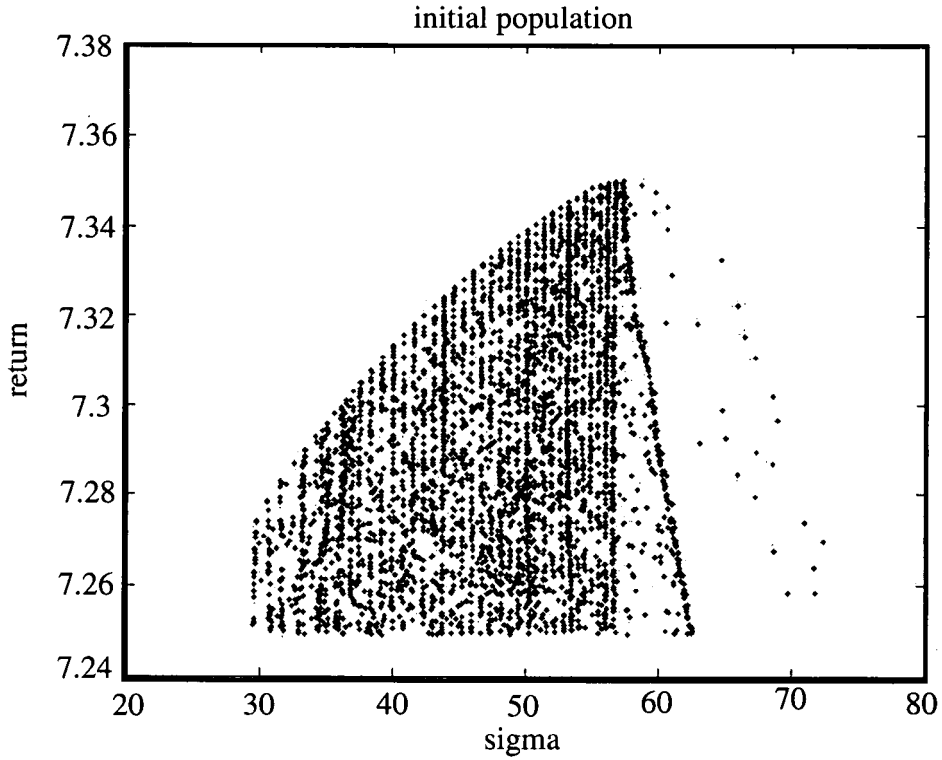
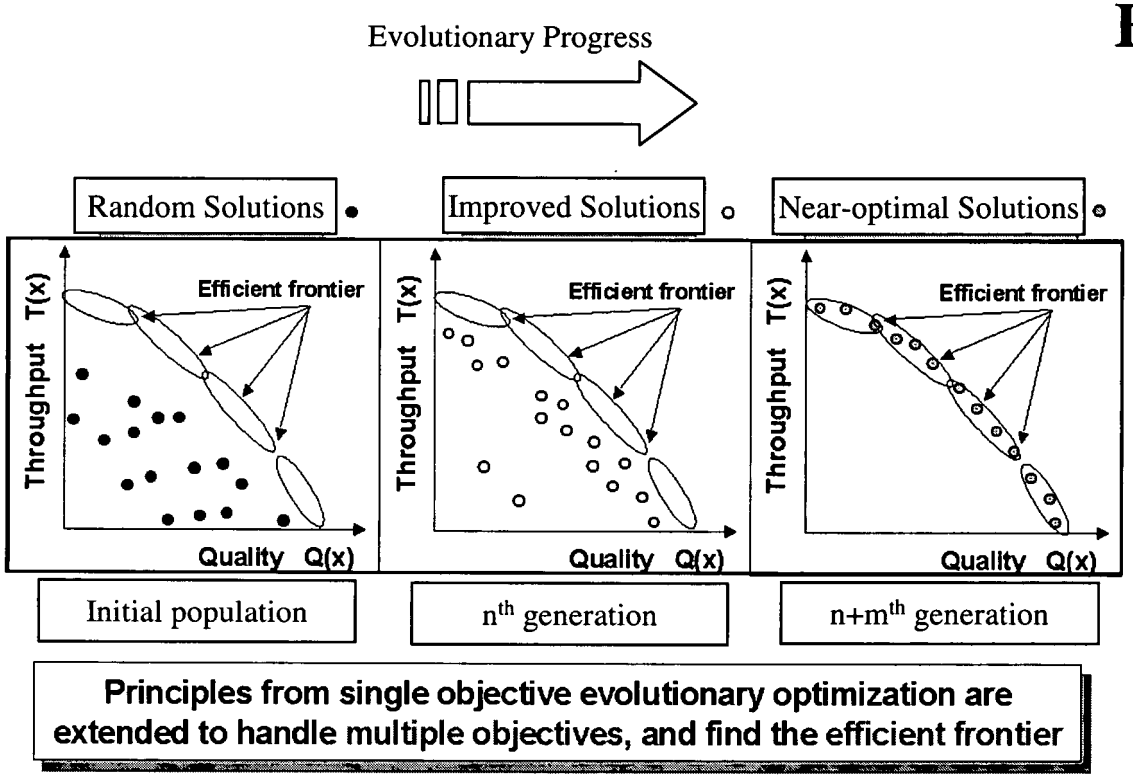


Fig. 5



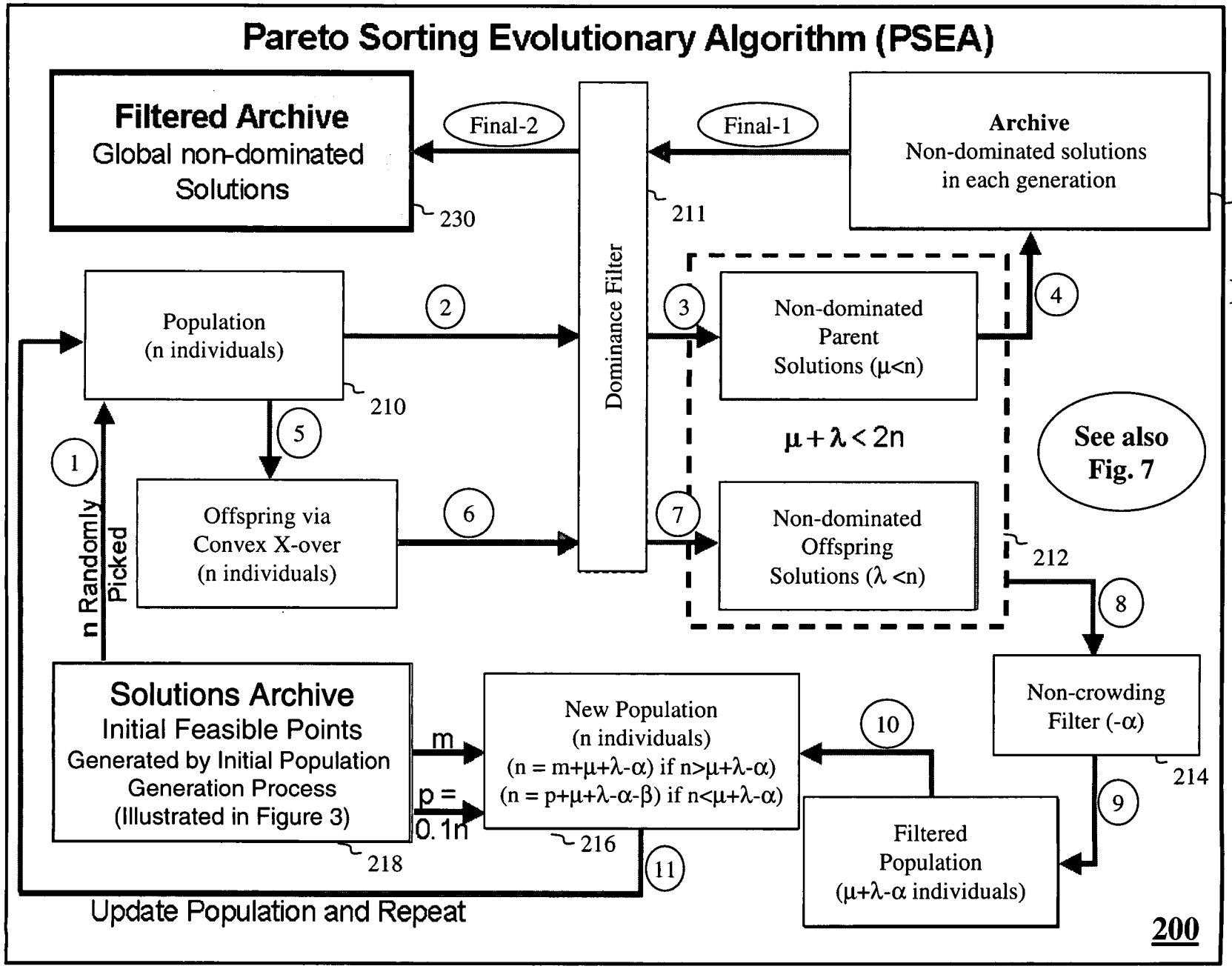

Pareto Sorting Evolutionary Algorithm (PSEA)
Filtered Archive
Global non-dominated Solutions
230
Final-2
Final-1
Dominance Filter
211
Archive
Non-dominated solutions in each generation
220
Population
(n individuals)
210
2
3
Non-dominated Parent Solutions (μ<n)
4
μ + λ < 2n
See also Fig. 7
1
5
n Randomly Picked
Offspring via Convex X-over
(n individuals)
6
7
Non-dominated Offspring Solutions (λ <n)
212
8
Solutions Archive
Initial Feasible Points
Generated by Initial Population Generation Process
(Illustrated in Figure 3)
218
m
p = 0.1n
New Population
(n individuals)
(n = m+μ+λ-α) if n>μ+λ-α)
(n = p+μ+λ-α-β) if n<μ+λ-α)
216
10
Non-crowding Filter (-α)
214
9
Filtered Population
(μ+λ-α individuals)
11
Update Population and Repeat
200

Fig. 6

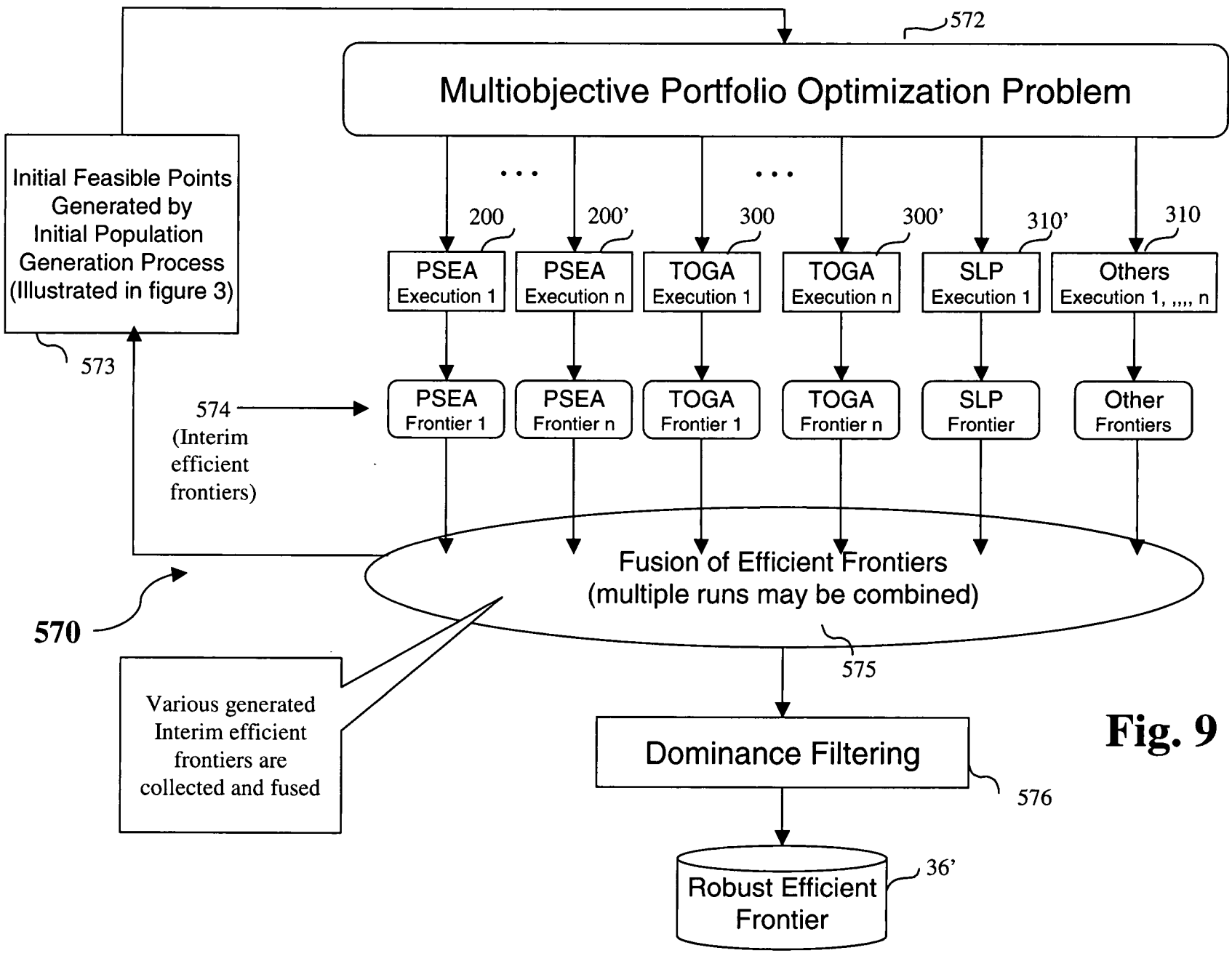

572
Multiobjective Portfolio Optimization Problem
Initial Feasible Points Generated by Initial Population Generation Process (Illustrated in figure 3)
573
200
200'
300
300'
310'
310
PSEA Execution 1
PSEA Execution n
TOGA Execution 1
TOGA Execution n
SLP Execution 1
Others Execution 1, ,,,, n
574
(Interim efficient frontiers)
PSEA Frontier 1
PSEA Frontier n
TOGA Frontier 1
TOGA Frontier n
SLP Frontier
Other Frontiers
Fusion of Efficient Frontiers (multiple runs may be combined)
570
575
Various generated Interim efficient frontiers are collected and fused
Dominance Filtering
576
Robust Efficient Frontier
36'

Fig. 9

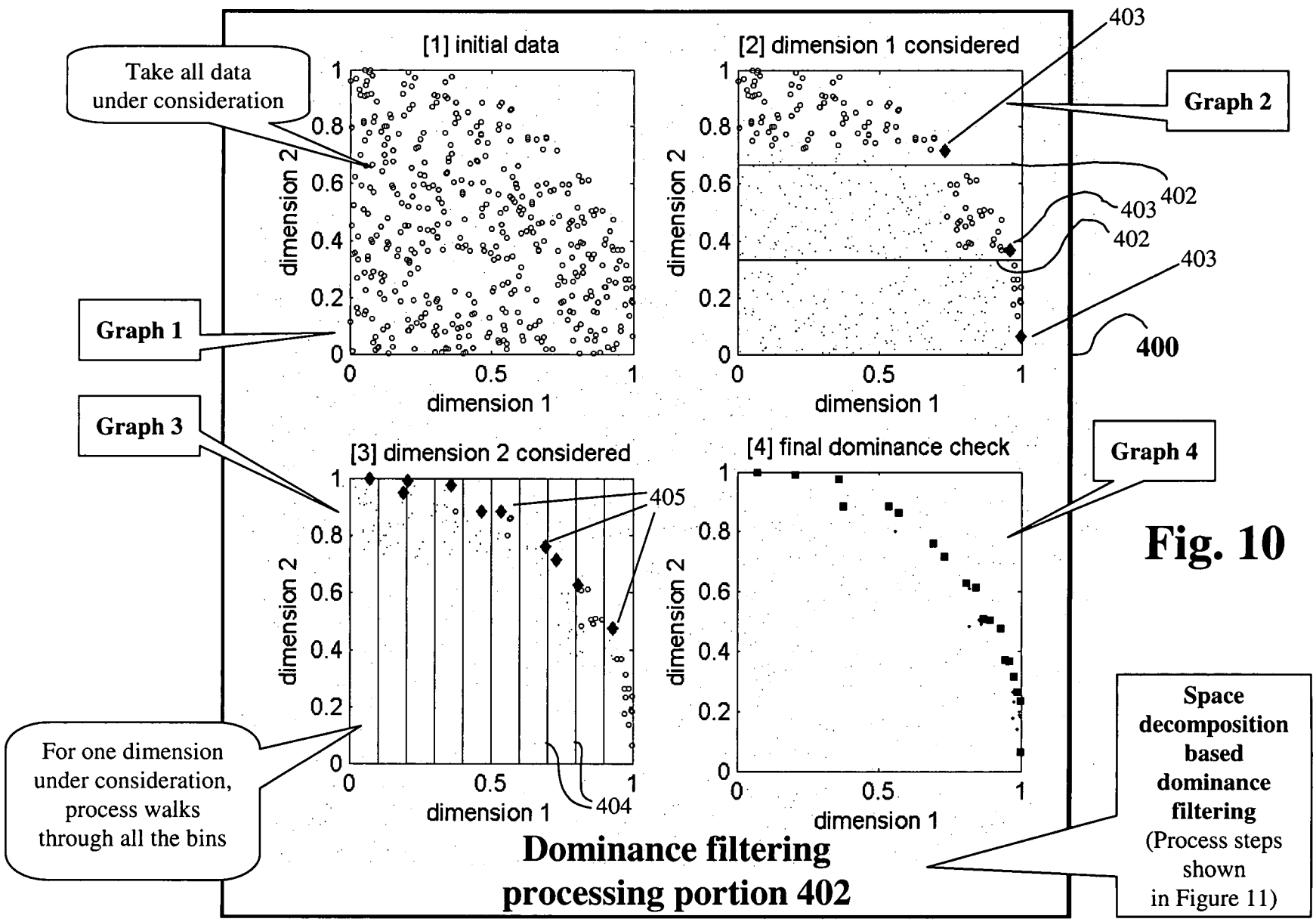


Fig. 10

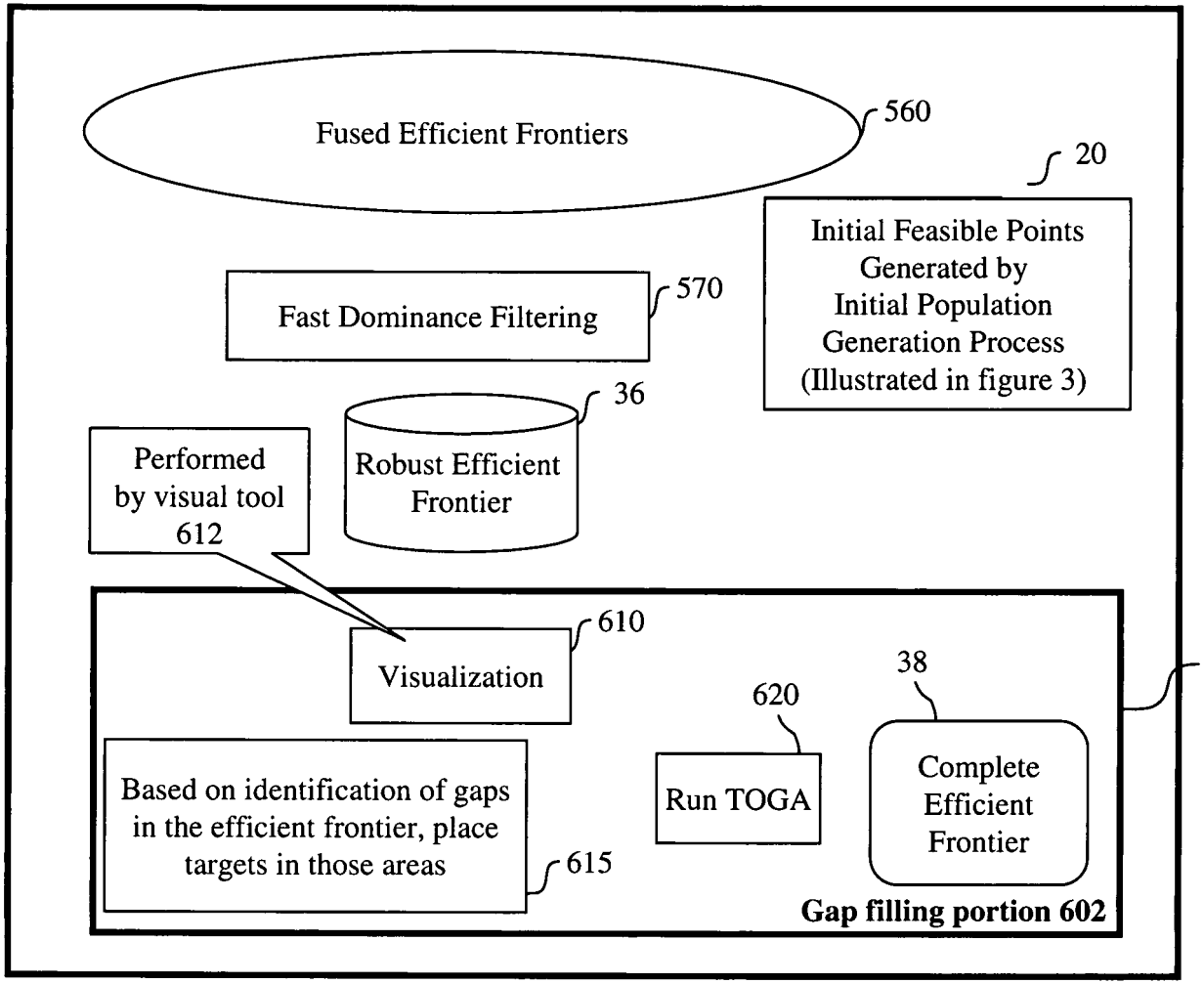


Fig. 12

Process to interactively fill any gaps in the identified efficient frontier

EXAMPLE OF PARALLEL COORDINATE PLOT

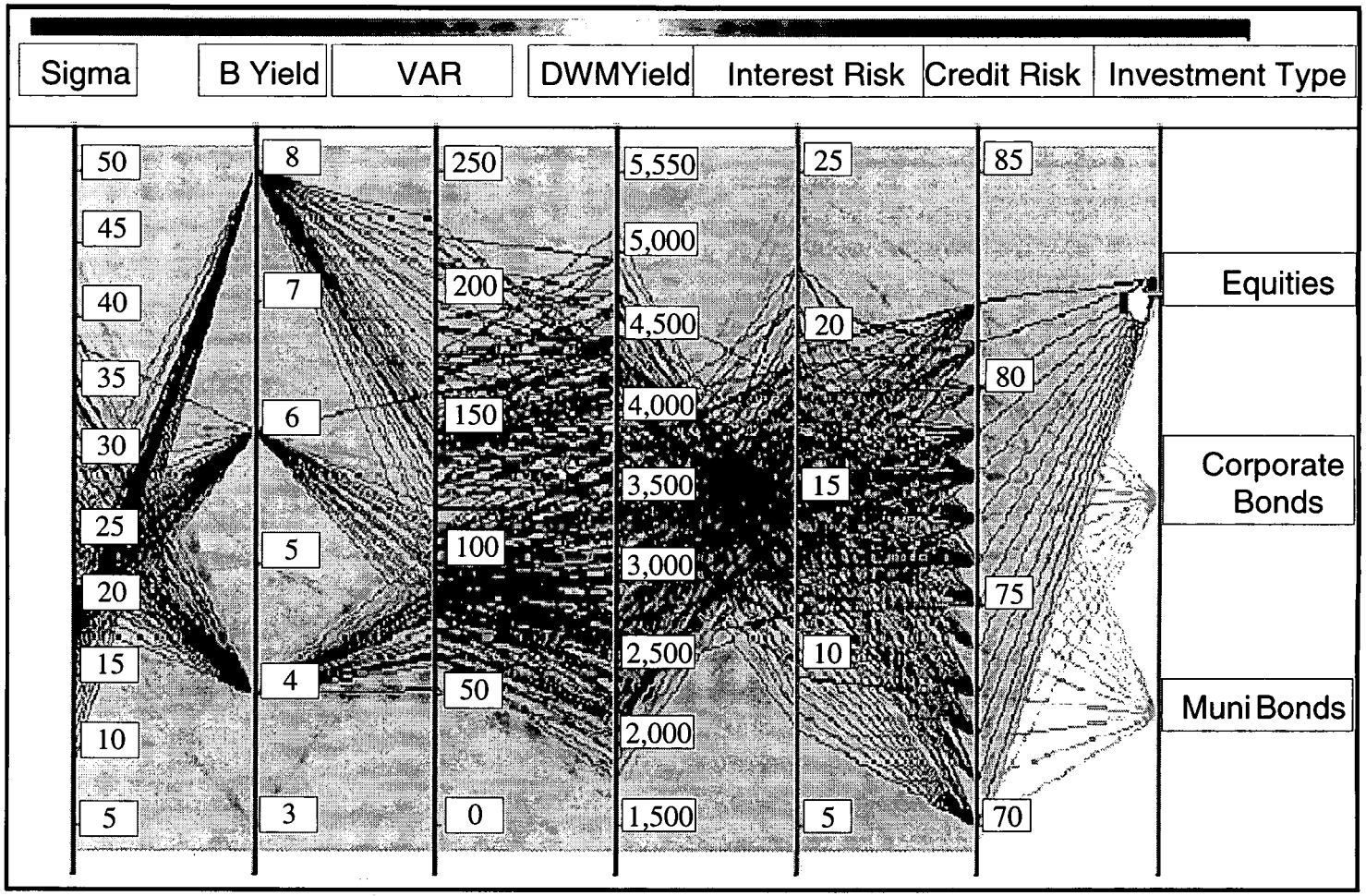


Fig. 14

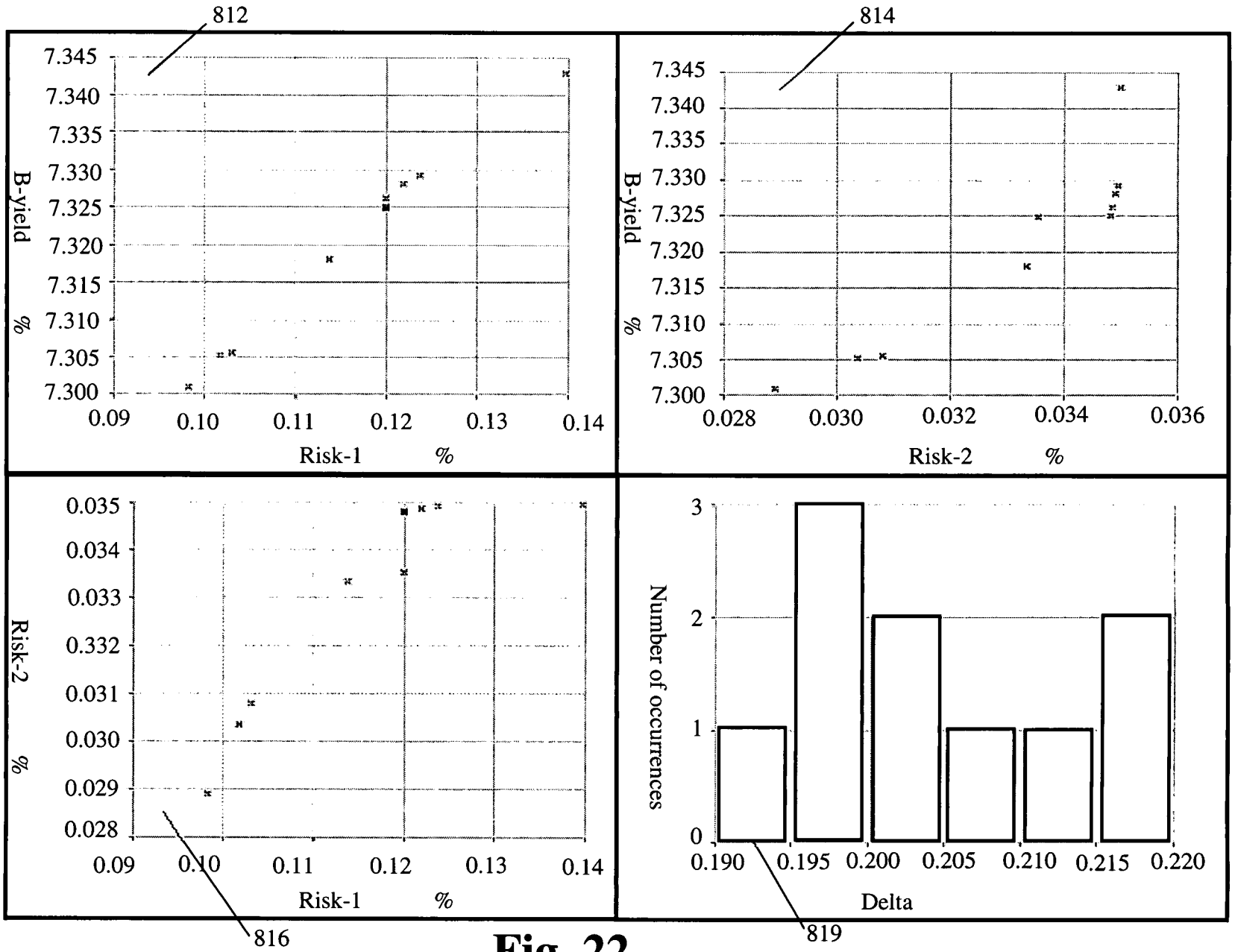

812
814
816
819
B-yield %
Risk-1 %
Risk-2 %
Number of occurrences
Delta
7.345
7.340
7.335
7.330
7.325
7.320
7.315
7.310
7.305
7.300
0.09
0.10
0.11
0.12
0.13
0.14
0.028
0.030
0.032
0.034
0.036
0.035
0.034
0.033
0.332
0.031
0.030
0.029
0.028
3
2
1
0
0.190
0.195
0.200
0.205
0.210
0.215
0.220

Fig. 22

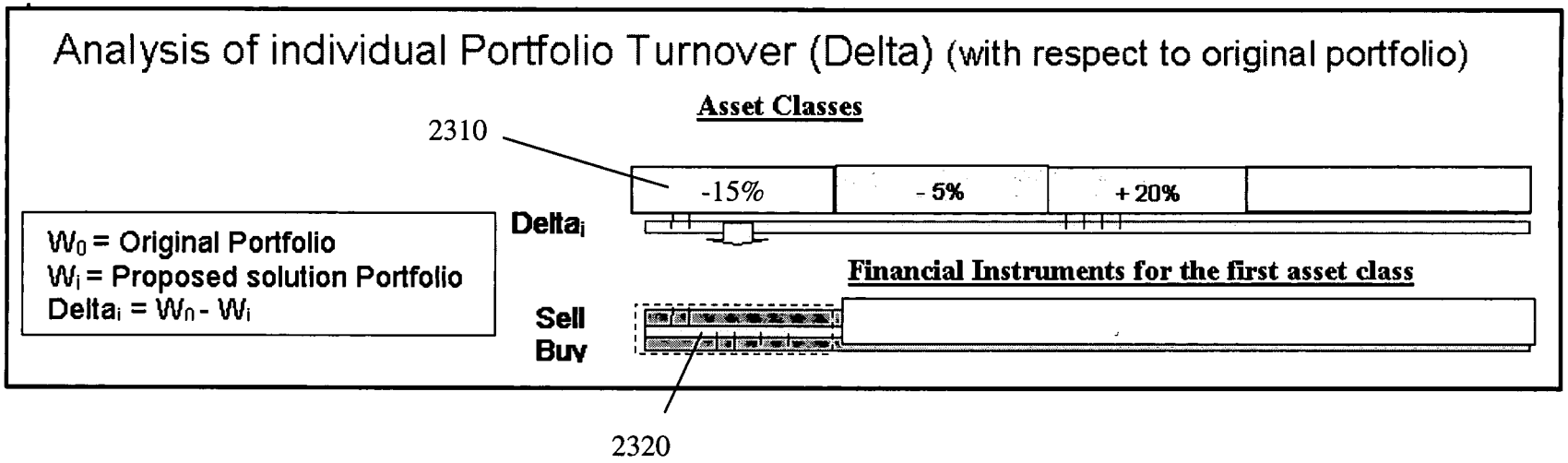


Fig. 23

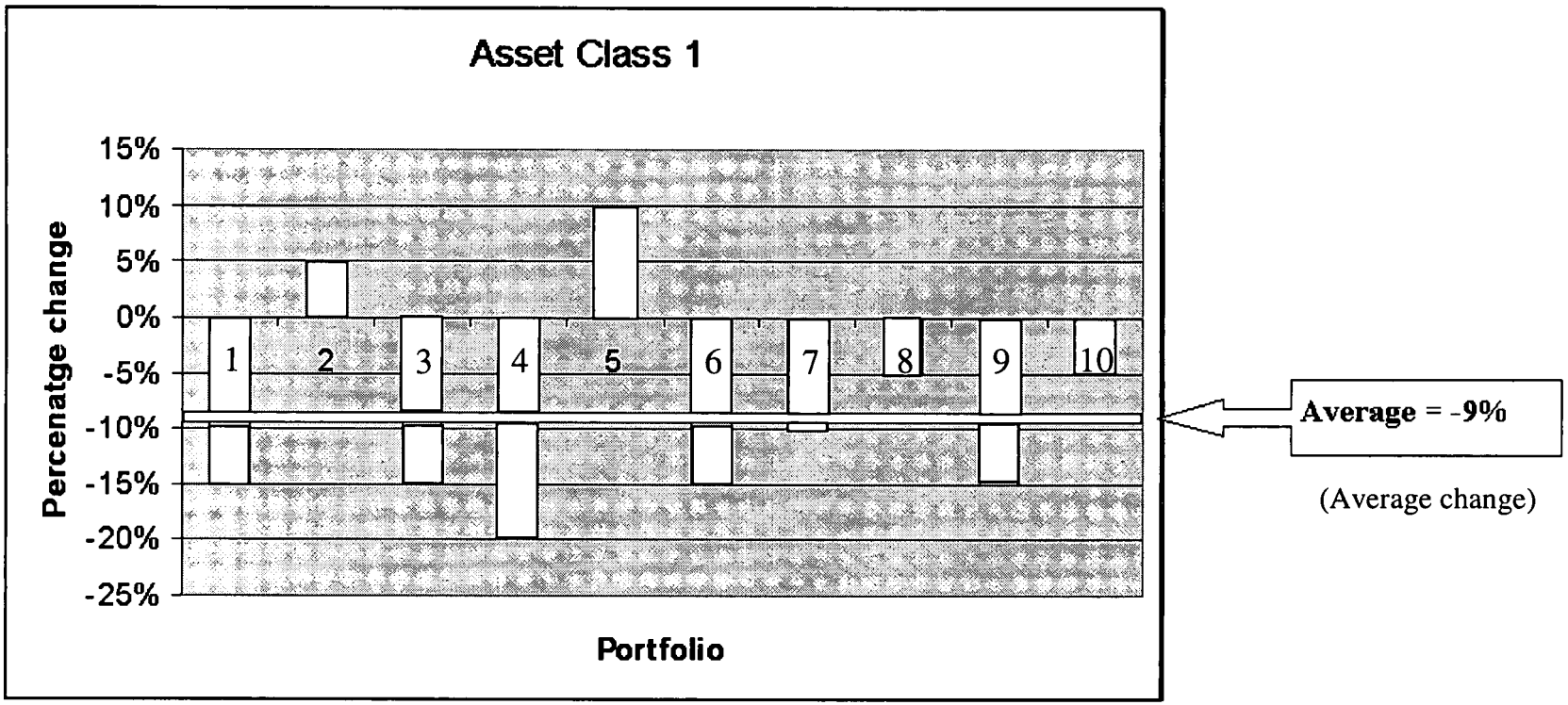


Fig. 26

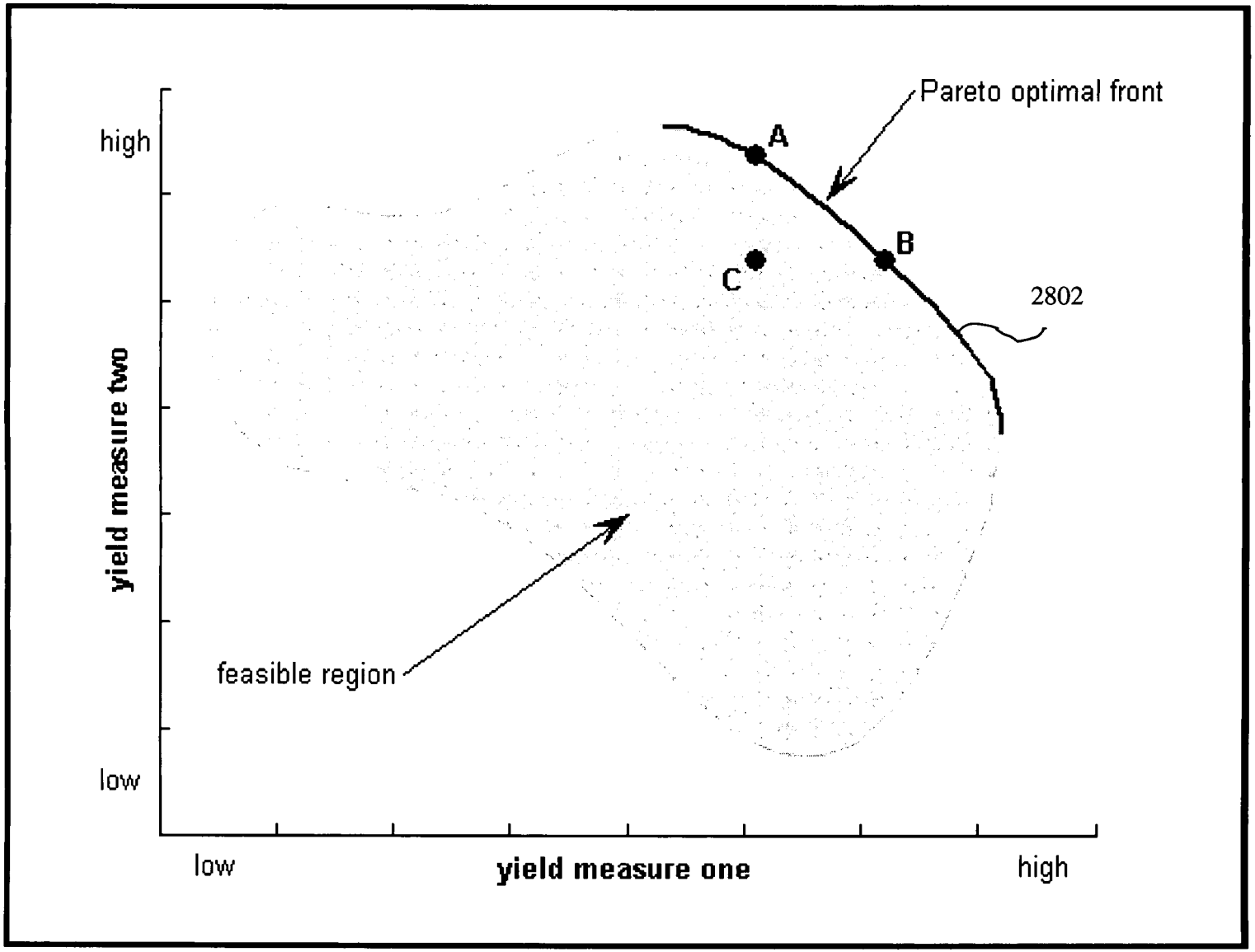
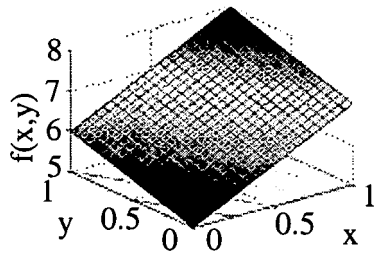
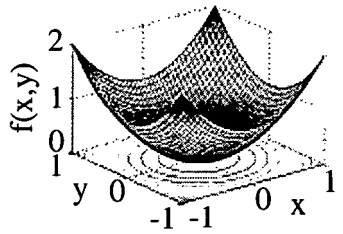
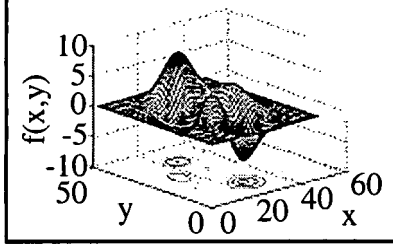


Fig. 28

Objective Functions

Figure 34

Graphic Visual	Word Description	Example Equation	GEAM
Linear Function 	• Function is defined using linear equations • Straightforward math relationship • Easy to optimize	$f(x, y) = 2x + y + 5$	• Market value weighted yield • Duration weighted yield
Nonlinear Convex Function 	• Function is defined using a nonlinear equation • Functional gradients lead to single optimum • Harder to optimize	$f(x, y) = x^2 + y^2$	• Interest rate sigma
Nonlinear Nonconvex Function 	• Function is defined using complex nonlinear equations • Multiple local optima • Functional gradients are inefficient • Very hard to optimize	$f(x,y)=g_1(x,y)+$ $g_2(x,y)+g_3(x,y)+$ $g_4(x,y)$	• Interest rate sigma and VAR